

University of Groningen

EC intercountry input-output relations

Linden, J.A. van der; Oosterhaven, J.

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

1996

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Linden, J. A. V. D., & Oosterhaven, J. (1996). *EC intercountry input-output relations: an income growth decomposition for 1970-1980*. s.n.

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

EC Intercountry Input-Output Relations: An Income Growth Decomposition for 1970-1980

by J.A. van der Linden and J. Oosterhaven¹

Abstract

This paper refines, develops and applies input-output decomposition analysis. First, by putting it in an unique intercountry perspective. Second, by concentrating on income growth. Third, by systematically separating the effects of technology changes from the effects of trade structure changes. The resulting matrix formula is applied to a set of EC input-output tables for 1970 and 1980 with 17 sectors and 5 EC-countries. As GDP growth is analyzed in nominal terms, nominal macro final demand growth is found to be most important component. The other five components relate to the effects of coefficient changes. Besides a richness of spatial and sectoral detail, they show two main tendencies. First, the negative income effects of the substitution away from primary input-intensive sectors and countries, and, second, the positive income effects of the substitution towards tertiary sectors, both in the case of sectoral technology and in the case of final output preferences.

Keywords income growth, technological change, trade structure change, decomposition analysis, European community

JEL C67, F15, F43, O10, O47

¹ Department of Economics, University of Groningen, Postbus 800, 9700 AV Groningen, The Netherlands (tel: 31-50-633740, fax: 31-50-637337). The authors thank Erik Dietzenbacher for his comments.

1. Introduction

Long term economic growth is influenced by a multitude of factors such as innovation, technological diffusion, trade protection and economic integration (cf. Maddison, 1991). At the national level, the impact of technological change per sector is well studied using, amongst others, input-output decompositions of national growth in total output (see Leontief, 1941; Chenery et al., 1963; Carter, 1970; for early applications and extensions, and Skolka, 1989; for a recent overview). Feldman, McClain and Palmer (1987) showed final demand increases to be the most important component of growth for 80% of 400 US industries that were distinguished in their analysis for 1963-1978. Technological changes proved to be most important only for industries that grew fastest or declined most. On the dominance of the final demand component they based their conclusion that the best industrial policy is a good macro economic policy.

Just like several other applications (see e.g. Stäglin and Wessels, 1972; Blair and Wyckoff, 1989; Fujimagari, 1989; Forssell, 1989; Holland and Cooke, 1992), Feldman et al. (1987) do not distinguish pure technology changes from changes in the openness of the economy, i.e. they do not separate the technical component from the trade component in the input-output coefficients. Studies that do make this distinction mostly make it only at a rather aggregate level, i.e. by means of one single import coefficient for all intermediate and final demand per commodity (see e.g. Kanemitsu and Ohnishi, 1989; Lee, 1990; Fujita and James, 1991). Per sector of origin, however, i.e. along the rows of an input-output table, the import ratios show large differences between total intermediate demand and total final demand, as well as between different individual sectors of destination (e.g. agriculture, industry and services) and different individual types of final demand (e.g. consumption and investment). (See Eurostat, 1986; for such differences in EC-countries.)

Hence, to separate the impact of technological change from the change in trade patterns it is necessary to use input-output tables that contain full matrices of imports for intermediate and final demand, respectively. As economic integration and protection often move hand in hand, an even more refined analysis is possible when for different countries such tables could be integrated

into full intercountry input-output tables (see Isard, 1951; for the first theoretical account).

Furthermore, it is of importance to focus such an analysis on total value added (as is done by e.g. Forssell, 1989) instead of on total output as done in most other cases. First, because value added is of course a more policy relevant indicator than total output. Secondly, because technological change not only relates to changes in the mix of intermediate inputs but also relates to changes in the ratio of primary inputs (capital, land and labour) to intermediate inputs.

In our analysis we will integrate the theoretical and empirical refinements, indicated above, into a decomposition of the growth of value added in the (old) European Community of five member states² for the period 1970-1980. The next section discusses the technical details of the decomposition and presents the arguments why alternative decompositions with different base years or continuous time need to be rejected. Section 3 then briefly explains the construction of the EC intercountry input-output tables for 1970 and 1980, and discusses the peculiarities of this database. Section 4 presents the empirical results at different levels of aggregation and the last section draws the main conclusions as regards the relative importance of technological changes vs changes in trade patterns vs changes in final demand.

2. Intercountry decompositions

Our intercountry decomposition of EC-value added changes starts with the basic interregional (i.e. intercountry) input-output model (cf. Miller and Blair, 1985). The solution of this model may be summarized as:

$$x = L f \tag{1}$$

² Excluding Luxembourg.

with:

x = an IR-column with total output per sector i ($i, j = 1, \dots, I$) and country r ($r, s = 1, \dots, R$);

f = an IR-column with final demand for products from sector i in country r ;

L = the IRxIR-intercountry Leontief-inverse.

Note that the diagonal blocks of this Leontief-inverse describe the domestic production multipliers. These domestic multipliers include the empirically small, but theoretically important intercountry feedback effects (cf. Oosterhaven, 1981; Miller and Blair, 1985). Furthermore, note that the off-diagonal blocks describe the intercountry spill-over effects on total output in country r as caused by final demand for products from country s . Hence, the columns of this intercountry Leontief-inverse describe the EC-wide production effects of final demand for products from sector i in country r (see for the empirical split-up between domestic and spill-over effects in the EC for 1959-1975, Oosterhaven, 1995, and for 1965-1985, van der Linden and Oosterhaven, 1995).

When (1) is given for two periods in time ($t = 0, 1$), the increase in total output can, basically, be decomposed in four different ways:

$$\begin{aligned} \Delta x &= x_1 - x_0 = L_1 f_1 - L_0 f_0 = \\ &= \Delta L f_0 + L_1 \Delta f \end{aligned} \quad (2)$$

$$= \Delta L f_1 + L_0 \Delta f \quad (3)$$

$$= \Delta L f_0 + L_0 \Delta f + \Delta L \Delta f \quad (4)$$

$$= \Delta L f_1 + L_1 \Delta f - \Delta L \Delta f \quad (5)$$

Note that (2) and (3) may also be derived by taking the total differential from (1), in which case the distinction between the base year 0 and the end year 1 disappears (cf. Kubo et al., 1986; Lee, 1990). However, if the decompositions are made for discrete time periods, this infinitesimal derivation is theoretically incorrect as it neglects the combined differences component present in (4) and (5). For periods of five and more years this may also present a serious empirical problem.

Although not negligible, the combined differences component will nevertheless be relatively small (see e.g. Uno, 1989; for Japan 1970-1975 and 1975-80). Moreover, this component is theoretically of clearly lesser interest than the components of (2) and (3). Hence, we prefer a choice between these two decompositions. Skolka (1989), in this context, points to the analogy with the choice between Laspeyres and Paasche indices. In that case a preference for Laspeyres volume indices and Paasche price indices may be based on the circularity principle applied to volumes (UN, 1975). In the case of the choice of applying the base year to the Leontief-inverse as in (2) or to final demand as in (3), no such preference exists. Decompositions (2) and (3) are basically equivalent, but produce different empirical outcomes. This is not recognized in e.g. Stäglin and Wessels, (1972), Barker (1990) and Holland and Cooke (1992). Therefore, following several other authors, we choose for the arithmetic average of (2) and (3):

$$\Delta x = \frac{1}{2} \Delta L (f_0 + f_1) + \frac{1}{2} (L_0 + L_1) \Delta f \quad (6)$$

which is equivalent to the arithmetic average of (4) and (5). Note that the order of matrix multiplication from (1) needs to be preserved in (6).

Instead of (6), however, we aim at a decomposition of the change in value added in such a way that a distinction is made between trade and technology changes, both for intermediate and for final demand. Hence, instead of the basic intercountry model (1) we want to decompose the change in the following extension and refinement of this basic model:

$$v = \hat{c} L f = \hat{c} L B y = \hat{c} (I - T^a \otimes A)^{-1} (T^f \otimes F) y \quad (7)$$

in which:

v = IR-column with gross value added at market prices per sector and country.
The other symbols will be explained below.

Through the pre-multiplication of (1) by:

\hat{c} = IR-diagonal matrix with corresponding value added coefficients;

total output is replaced by value added, and the impact of $\Delta \hat{c}$ becomes the first of the two components that relate to sectoral technology changes.

The second sectoral technology component is derived from the changes in

the intercountry Leontief-inverse, which itself is calculated as:

$$L = (I - T^a \otimes A)^{-1} \quad (8)$$

in which:

T^a = IRxIR-matrix of trade coefficients (t_{ij}^{rs}) indicating which fraction of the intermediate demand for products from worldwide sector i (exercised by sector j in country s) is actually satisfied by supply from country r ;

A = IRxIR-matrix of technical coefficients (a_{ij}^{rs}), built up of R mutually identical $I \times I$ -matrices, indicating the total need of products from worldwide sector i by sector j in country s per unit of output of j in s .

Thus, in (8) the intercountry input coefficients are decomposed into a trade part and a technical part, as follows:

$$a_{ij}^{rs} = t_{ij}^{rs} \cdot a_{ij}^{rs} \quad (9)$$

where the dot indicates a summation over all countries of origin. Note that (9) shows that the order of the Hadamard-product \otimes in (8) may be changed.

The decomposition of changes in (8) is based on:

$$\Delta L = L_1 \Delta(T^a \otimes A) L_0$$

from which, using the rules that led to (6), it easily follows that:

$$\Delta L = \frac{1}{2} L_1 (T_0^a + T_1^a) \otimes \Delta A L_0 + \frac{1}{2} L_1 \Delta T^a \otimes (A_0 + A_1) L_0 \quad (10)$$

The first part of (10) indicates the impact of the actual changes in technology on the Leontief-inverse, whereas the second part indicates the combined impact of the actual changes in the trade coefficients.

The last two components of (7) relate final demand for products from sector i in country r to macro economic demand categories, viz. consumption, government expenditures, investment and exports to third countries. Again a distinction is made as regards the trade (i.e. spatial origin) and the "technology" (i.e. sectoral origin) dimension:

$$f = B y = (T^f \otimes F) y \quad (11)$$

in which:

- $T^f =$ IRxQR-matrix with trade coefficients (t_{iq}^{rs}) per category of final demand q ($q = 1, \dots, Q$) in country s ;
- $F =$ IRxQR-matrix with final demand composition or "technology" coefficients (f_{iq}^s), which is built up just like A , viz. with R mutually identical IxQR-matrices;
- $y =$ QR-column with macro economic final demand of category q in country s .

In (11) the Hadamard-product $T^f \otimes F$ shows the decomposition of the final demand or "bridge" coefficients B (inter alia used by Feldman et al., 1987) into a "trade" and a "technology" component, as follows:

$$b_{iq}^{rs} = t_{iq}^{rs} \cdot f_{iq}^{rs} \quad (12)$$

where the dot again indicates a summation over countries of origin.

Using the rules that led to (6), the decomposition of the first order difference in B is simple:

$$\Delta B = \frac{1}{2} \Delta T^f \otimes (F_0 + F_1) + \frac{1}{2} (T_0^f + T_1^f) \otimes \Delta F \quad (13)$$

In (13) the first part indicates the impact on B of the changes in the trade pattern for final output and the second part indicates the impact of changes in "final demand technology". The most important of which are the changes in consumers' preferences.

The final decomposition of (7) into six additive components is reached by taking the arithmetic average of all possible decompositions³. These mutually equivalent but empirically different variants may be derived in two steps. First, the basic procedure of (6) is applied to (7) which results into four components related to, respectively, changes in \hat{c} , L , B and y . Second, the auxiliary decompositions (10) and (13) are substituted into the appropriate components of (7), which finally results into six components:

³ Strictly spoken, only those decompositions are considered that use the same (base or end) year before the Δ and the same (end or base) year after the Δ in the basic decomposition of (7), i.e. before (10) and (13) are substituted.

$$\Delta v = \frac{1}{2} \Delta \hat{c} \{L_1 B_1 y_1 + L_0 B_0 y_0\} \quad (14.1)$$

$$+ \frac{1}{4} \{ \hat{c}_0 L_1 (T_0^a + T_1^a) \otimes \Delta A L_0 B_1 y_1 + \hat{c}_1 L_1 (T_0^a + T_1^a) \otimes \Delta A L_0 B_0 y_0 \} \quad (14.2)$$

$$+ \frac{1}{4} \{ \hat{c}_0 L_1 \Delta T_a \otimes (A_0 + A_1) L_0 B_1 y_1 + \hat{c}_1 L_1 \Delta T_a \otimes (A_0 + A_1) L_0 B_0 y_0 \} \quad (14.3)$$

$$+ \frac{1}{4} \{ \hat{c}_0 L_0 \Delta T^f \otimes (F_0 + F_1) y_1 + \hat{c}_1 L_1 \Delta T^f \otimes (F_0 + F_1) y_0 \} \quad (14.4)$$

$$+ \frac{1}{4} \{ \hat{c}_0 L_0 (T_0^f + T_1^f) \otimes \Delta F y_1 + \hat{c}_1 L_1 (T_0^f + T_1^f) \otimes \Delta F y_0 \} \quad (14.5)$$

$$+ \frac{1}{2} \{ \hat{c}_0 L_0 B_0 + \hat{c}_1 L_1 B_1 \} \Delta y \quad (14.6)$$

These six components can of course be combined in several ways.

The first two summarize the impacts of changes in sectoral technology, as they relate to respectively $\Delta \hat{c}$ and ΔA . It is important to note that a negative contribution of $\Delta \hat{c}$ in fact indicates an increased efficiency in the use of primary factors of production (capital, labour, land). The next two components summarize the impact of changes in the trade pattern, as they relate to ΔT^a and ΔT^f . Here, it is important to note that in the case of the EC these changes have two dimensions, namely an external and an internal one. The external one relates to changes in openness with the rest of the world, whereas the internal one relates to changes in trade pattern between EC-member states⁴. Finally, the last two components relate to the composition and size of macro economic demand per category and country.

The results of the application of (14) to the EC-intercountry input-output tables of 1970 and 1980 will of course also depend on the peculiarities of the data used. The construction of this data base will be discussed in the next session.

⁴ This can easily be seen from the fact that the external dimension,

$1 - \sum_{i=1}^R t_{ij}^{rs} \geq 0$, is not constant in time.

3. The EC Intercountry Input-Output Tables

The intercountry input-output tables of the European Community for 1970 and 1980 are constructed from a set of harmonized national input-output tables (see Eurostat, 1979, for the methodology). In these national tables, domestic transactions are valued in producers' prices and imports in ex-customs prices. All prices are current prices; there are no tables at constant prices available. Furthermore, the imports are distinguished according to two origins, namely imports from within and imports from outside the EC. Thus, information with regard to the value added coefficients (c_i^r), the domestic input coefficients (a_{ij}^{tr}) and the domestic bridge coefficients (b_{iq}^{tr}) may be derived from these data directly. Such tables are issued every five years (see for 1970 and 1980: Eurostat, 1979 and 1986), but are not available for all member states. For both years there are no tables for Luxembourg, and for 1980 the tables for Ireland and Greece are lacking too.

To obtain the intercountry tables, the intra-EC imports (for both intermediate and final use) are first disaggregated into the bilateral transactions between all pairs of EC-countries. This is done with intra-EC import coefficients (h_i^{rs}) derived from international trade data (as harmonized in Eurostat, 1990), together with the following assumptions:

$$h_{ij}^{rs} = h_{iq}^{rs} = h_i^{rs} \quad \text{for all } j \text{ and } q \quad (15)$$

These intra-EC trade coefficients are then applied to the intra-EC imports (z_{ij}^{es} and y_{iq}^{es}) to derive a first estimate of the intra-EC intercountry input coefficients and bridge coefficients, necessary for (9) and (12), namely:

$$a_{ij}^{rs} = (h_i^{rs} z_{ij}^{es}) / x_i^s = h_i^{rs} (z_{ij}^{*s} - z_{ij}^{ss}) / x_i^s = h_i^{rs} (a_{ij}^{*s} - a_{ij}^{ss}) \quad (16)$$

and analogously:

$$b_{iq}^{rs} = h_i^{rs} (f_{iq}^{*s} - f_{iq}^{ss}) \quad (17)$$

Consequently, the first estimates of the intercountry trade coefficients in T^a and T^f , which can be derived from (16) and (17), differ among different destinations j and q , such contrary to the suggestion in (15).

As the disaggregated imports are still valued in ex-customs prices, a second

step is necessary to reassess them into producers' prices. The RAS-method is used to do this. Details of the construction method are given in Van der Linden and Oosterhaven (1995).

For earlier constructions and applications of EC intercountry input-output tables, see Schilderink (1984), Langer (1987), Lanza and Rampa (1988), Oosterhaven (1995) and Fehr et al. (1991). All these tables, however, represent inconsistent data bases as ex-customs prices were not reassessed.

The original input-output tables of Van der Linden and Oosterhaven (1995) have 44 sectors. For our present analysis, we aggregated them into 17 sectors. For 1980 we only regard the five countries that were present in 1970. Furthermore, for presentation reasons, we aggregated most empirical results into 6 sectors.

4. The empirical decomposition results

Table 1 shows the growth of value added during the 1970s. Unfortunately, as constant price EC input-output tables are not available, this growth is measured in nominal terms. Note that the nominal growth of the services industries is largest and the growth of the good producing industries is smallest. This well known phenomenon is partly due to the inverse difference in labour productivity growth which causes prices of services to rise far faster than those of goods. There are, however, significant differences in nominal growth rates within manufacturing and market services (see table 3), which require further explanation.

Table 1 also shows large differences between the growth rates of different countries, with the Netherlands in a lonely top position (+ 274%). The growth of energy prices in the seventies clearly benefitted the Netherlands, which had a large and increasing production of natural gas. The Netherlands, furthermore, benefitted from its strategic distribution function as shown in its strong growth in market services. The continuation of this locational advantage, of course, strongly depends on further economic integration of the EC. Another sector that strongly profits from integration is manufacturing. Here, Italy reaped the largest gains.

Table 1 Growth of value added* in %, 1970-1980

	D	F	I	N	B	EC
Agriculture	96	93	113	119	96	102
Energy	179	201	130	504	211	198
Manufacturing	141	164	212	134	141	159
Building	133	159	175	253	236	160
Market-Services	274	242	233	326	242	257
Public-Services	298	320	250	384	389	306
Total	200	210	208	274	223	210

* Measured in current ECU's "gross" and "at market prices".

As our figures refer to nominal growth, overall macro economic growth will of course be the most important component as it is the only one that measures changes in ECU's. The other five components (14.1)-(14.5) all relate to changes in the model's coefficients, in which only changes in relative prices are of importance. Hence, we first analyze the structure of the nominal growth of final demand (Δy) in some more detail (table 2).

First, note that the country totals of table 2 are unequal to those of table 1. A large part⁵ of these differences is caused by the fact that imports from third countries have to be subtracted from the total of table 2 to come closer to the total of table 1, as follows from the definition:

$$C + G + I + E = \text{GDP} - M \quad (18)$$

for the EC as a whole. The differences between the totals of table 1 and 2 therefore imply that imports from third countries must have grown faster than

⁵ Furthermore, at the national level intra-EC exports and intra-EC imports have to be added and subtracted, whereas further minor differences are caused by non-zero trade balances per country and by the fourth quadrant in the intercountry EC input-output table.

Table 2 Growth of final demand in %, 1970-1980

	D	F	I	N	B	EC
Consumption	201	225	196	285	222	214
Government	334	278	301	321	346	310
Investments	142	157	226	170	183	164
Exports to TC	305	410	331	385	338	343
Total*	212	228	227	278	245	226

* Calculated as $C + G + I + E$.

the average of EC final demand. Table 2 shows that the same holds for the exports to third countries. Both facts clearly show that the external openness of the EC grew considerably. Definitely, in the 1970s Europe was not becoming a fortress!

Second, table 2 shows that government expenditures grew rather fast too, especially in Belgium and Western Germany. This growth will, of course, appear to be the major factor explaining the strong growth of public services. The growth of consumption and, especially, investments was relatively weak in the 1970s. As for consumption, the Netherlands is an exception again, with a rather high growth percentage. This is partly explained by the strong growth of natural gas income, which was primarily consumed (partly through increasing social security benefits) and not invested. For investments, Italy clearly heads the list. This partly reflects the strong growth of its manufacturing sector.

Table 3 shows the full results of our decomposition analysis. Most striking is the dominance of the macroeconomic component (6), which is due to the fact that we are analyzing the impact of the nominal developments that were indicated in table 2. Next, it appears that the influence of the other five factors, which relate to technology and trade patterns, is predominantly negative. This means that both spatially and sectorally there is a dominant shift to input sources that use EC-labour, -land and -capital less intensively.

Table 3 Decomposition* of EC value added growth per sector, 1970-1980

	(1)	(2)	(3)	(4)	(5)	(6)	Total
Agriculture	-17	-14	-2	-7	-36	177	101
Energy	-78	51	-31	-8	42	212	189
Manufacturing	-11	-8	-6	-8	-12	193	149
- Metals	-30	-41	-10	-6	-9	164	68
- Minerals	-28	-6	-5	-2	2	179	141
- Chemicals	-50	7	-9	-6	-10	200	133
- Metal Products	-1	-2	-6	-8	-7	193	169
- Transport Equip.	14	-7	-4	-9	10	218	223
- Food	-3	-9	-1	-4	-38	193	140
- Textiles & Leather	5	-11	-12	-21	-33	190	118
- Wood & Paper	-25	-18	-5	-4	-1	187	135
- Other Manufact.	-16	11	-7	-12	0	209	185
Building	-5	-3	0	0	-3	170	159
Market services	4	12	-4	-1	7	233	251
- Rep.&Trad.&Lodg.	9	-10	-2	-2	-1	215	209
- Transport&Comm.	-10	12	-10	-4	-7	221	201
- Financial Serv.	-71	55	-8	-1	33	226	234
- Other Services	11	46	-3	1	30	270	355
Public Services	5	4	-1	-1	15	283	305
Total	-8	4	-5	-4	1	217	204

* According to (14.1)-(14.6), with aggregation over the five member states, in % of EC sectoral value added in 1970.

When we look more closely at table 3, we see that this trend is most consistent for the two trade components, (3) and (4). In the case of trade, this trend is caused by two shifts. First, a shift from inputs produced within the EC

towards inputs produced in third countries. This influence is very clear in the negative effect of trade shifts in the A-matrix, on the growth of value added in the Energy sector (-31%). It also shows itself in the negative effect of trade shifts in the B-matrix on the growth of value added in the Textiles & leather industry (-21%). Second, shifts in trade patterns within the EC towards less value added intensive countries play a role.

The first component shows that there is not only a shift towards sectors and countries that use less value added per unit of output, but that the value added coefficients themselves showed a systematic decline. This decline has its strongest influence on value added in the Energy sector (-78%) and in energy intensive sectors, such as Metals (-38%), Minerals (-28%), Chemicals (-50%) and Wood & paper (-25%). In all cases the decrease in value added has to be attributed in part to the rise in energy prices, as the input coefficients relate to the relative amounts spent on the inputs concerned.

The negative influence of the change in the value added coefficients of Financial services on its EC-wide growth is also quite large (-71%). Only a few sectors have increasing value added coefficients and in those cases the effect on EC-wide growth in value added in that sector does not exceed the +14% of the transport equipment sector.

Only the second and the fifth component show significant exceptions to the basic trend of shifts towards less primary factor intensive inputs. The most striking exceptions are the Energy sector, the Financial services and the Other market services. For these sectors changes in the technical coefficients have a positive effect on value added growth of, respectively, +51%, +55% and +46%. In all cases, this positive effect of technological changes is matched by comparable positive effects of changes in final demand composition of, respectively, +42%, +33% and +30%. In the case of the Energy sector, price changes again play an important role. The EC Energy sector obviously benefitted from worldwide energy price increases in that it was able to reap some of the benefits. The same may hold true for the Chemicals, but to a lesser degree (+7%).

In the case of the Financial and Other market services, the positive effect of changes in technical and final demand coefficients on value added growth is part of a wider phenomenon. Smaller but equally systematic positive terms are found for Public services. Obviously these sectors benefit from the increasing tertiarization of the economy in both production activities and consumption activities. Transport and communication also benefits from changes in technical coefficients (+12%), but not from changes in final demand composition (-7%). Here it is the transport equipment sector (i.e. private cars) that benefits (+10%) from changes in preferences for final outputs.

Changes in final demand preferences also have negative effects on value added growth. The latter are most prominent in sectors that serve the primary needs of people, such as Agriculture (-36%), Food (-38%) and Textiles & leather (-33%).

In the above analysis, we concentrated on the differences between sectors for the EC as a whole. Next, in table 4, we will analyze the differences between the EC-countries. To neutralize the scale effect of the overall growth of value added per sector per country (see table 1) we have standardized the sum of all six components at 100%.

First, we look at Agriculture. Macroeconomic growth (6) contributes most. In Italy, the negative influence of coefficient changes (i.e. the first five components), is the smallest (-51%). The country by country differences between the components are mostly small, but with some exceptions. The value added coefficient in France decreased considerably, contributing -33% to the total growth of value added, whereas it increased in Germany leading to a +5% share in total agricultural value added growth. Furthermore, Germany and Belgium together stand out for relatively large negative shares of the impact of technological and trade pattern shifts, in total value added growth in agriculture.

Second, in the case of Energy, the absolute impact of coefficient changes is especially large for Italy (-48%) on the one end and for the Netherlands on the other end (+27%). The decrease in Italy's value added coefficients contributes -80% to Italy's rather small growth in Energy value added (+130%, see table 1). The Netherlands take advantage of changes in both technical and final demand

Table 4 Decomposition* of value added growth per sector per country, in %, 1970-1980

	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture, EC	-17	-27	-4	-9	-22	179
- Germany	5	-39	-14	-12	-22	182
- France	-33	-27	-1	-13	-27	202
- Italy	-13	-19	0	-2	-17	151
- Netherlands	-21	-27	-4	-6	-25	184
- Belgium	-14	-36	-11	-19	-20	200
Energy, EC	-40	27	-16	-4	22	111
- Germany	-40	29	-22	-5	22	115
- France	-42	28	-17	-6	27	111
- Italy	-80	32	-13	-6	20	148
- Netherlands	0	15	-3	2	13	73
- Belgium	-49	26	-12	-2	24	114
Manufacturing, EC	-5	-6	-4	-5	-9	128
- Germany	-2	-10	-6	-5	-11	134
- France	0	-8	-5	-6	-8	126
- Italy	-12	5	1	0	-1	107
- Netherlands	-26	-10	0	-10	-22	168
- Belgium	-11	-9	-10	-10	-14	154
Building, EC	-3	-1	0	0	-2	107
- Germany	-5	-5	-2	0	1	111
- France	2	-1	0	0	-4	104
- Italy	-7	2	0	0	-14	119
- Netherlands	-7	9	8	-1	6	85
- Belgium	-2	1	-1	0	13	88
Market services,	1	6	-2	-1	3	93
- Germany	7	5	-2	-1	5	86
- France	-2	5	-2	-1	1	99
- Italy	-9	9	0	0	4	95
- Netherlands	4	6	-2	-4	2	93
- Belgium	-2	8	-5	0	-1	100
Public services, EC	2	1	0	0	5	93
- Germany	-2	3	0	0	5	95
- France	7	0	0	0	7	87
- Italy	0	2	0	0	-6	104
- Netherlands	0	0	0	-4	15	88
- Belgium	4	0	0	0	7	89

* According to (14.1)-(14.6), with the row total standardized at 100%.

coefficients, which contribute, respectively, +15% and +13% to the very large growth of its Energy sector's value added (+504%, see table 1). This is due to price increases of its natural gas. Contrary to the rest of the EC, the Dutch Energy sector is the only one that has the benefit of a constant value added coefficient. The largest country by country differences in contributions to value added growth in the Energy sector are found in the first two columns. They relate to the considerably different impact of technology changes on income earned in the Energy sectors.

The other four sectors show much smaller intra-EC differences. In the case of Manufacturing and Services, this is partly due to their aggregate and therefore heterogeneous character. In Manufacturing, the largest negative shares of the first five components are found in the Netherlands (-68%) and Belgium (-54%). There, the dominant tendency of shifts to sectors and countries with small value added coefficients is found in all five components. Building only stands out because of some positive (as opposed to negative) contributions of technological changes and final demand composition changes.

In all countries, macroeconomic growth explains almost all growth in value added in the Services sectors. Given the mainly domestic orientation of services this is not very surprising. Technological change (i.e. tertiarization) has a positive share in income growth in all countries. There is, however, a small, but interesting difference between Market and Public services. Market services benefit primarily from changes in sectoral technology, whereas Public services mainly benefit from changes in final demand preferences (except for the -6% for Italy).

Finally, we note that larger country by country differences are found at the more disaggregate level⁶.

5. Conclusions

The above analysis presents a refinement of standard decomposition analyses of long term changes in sectoral output in several respects. First, it focuses on

⁶ Results for 17 sectors are available upon request.

income growth instead of output growth. Second, it systematically distinguished between changes in technology and changes in trade patterns, both in the case of changes in sectoral input coefficients and in the case of changes in final demand (or bridge) coefficients. Third, it employs intercountry input-output tables instead of national tables.

The empirical results show three main tendencies, the first of which is not surprising. As EC input-output tables are not available in constant prices, the nominal growth of aggregate final demand explains most of the nominal growth in each sector in each country. Second, and more important, we found a dominant tendency to substitute, both sectorally and spatially, primary factor extensive products for primary factor intensive products. As most sectors themselves also showed a decrease in their value added coefficients, this indicates an unambiguous growth in productivity, within production processes as well as between them because of substitution. Finally, we found a clear tendency towards tertiarization, both in intermediate demand (i.e. in sectoral technology) and in final demand (i.e. mainly in consumption preferences).

References

- Barker, T., 1990, Sources of structural change for the UK service industries 1979-84. *Economic Systems Research* 2, 2, pp. 173-183.
- Blair, P.D. and A.W. Wyckoff, 1989, The changing structure of the US economy. An input-output analysis. In: R.E. Miller, K.R. Polenske and A.Z. Rose (eds.), *Frontiers of Input-Output Analysis*. Oxford University Press, New York, pp. 293-307.
- Carter, A.P., 1970, *Structural change in the American economy*. Cambridge, Mass., Harvard University Press.
- Chenery, H.B., S. Shishido and T. Watanabe, 1963, The pattern of Japanese growth, 1914-1954. *Econometrica* 30, 1, pp. 98-139.
- Dietzenbacher, E., J.A. van der Linden and A.E. Steenge, 1993, The Regional Extraction Method: Applications to the European Community. *Economic Systems Research* 5, 2, pp. 185-206.
- Eurostat 1978, *Input-Output Tables, the Nine and the Community, 1970*, Special series 8-1978, Luxembourg.
- , 1979, *European System of Integrated Economic Accounts, ESA*, 2nd. ed., Luxembourg.
- , 1986, *National Accounts ESA Input-Output Tables 1980*, Luxembourg.
- , 1990, *External Trade Statistics: User's Guide*, Luxembourg.
- Fehr, H., C. Rosenberg and W. Wiegard (1991), A Multi-Country Applied General Equilibrium Model for the Examination of VAT-Harmonization Microconsistent Dataset, *Regensburger Diskussionsbeiträge zur Wirtschaftswissenschaft*, Nr. 236, Universität Regensburg.
- Feldman, S.J., D. McClain and K. Palmer, 1987, Sources of structural change in the United States 1963-1978: An input-output perspective. *Review of Economics and Statistics* 69, 3, pp. 503-510.
- Forssell, O., 1989, The input-output framework for analysing transmitting of technical progress between industries. *Economic Systems Research*, 1, 4, pp. 429-445.
- Fujimagari, D., 1989, The sources of change in Canadian industry output.

- Economic Systems Research* 1, 2, pp. 187-201.
- Fujita, N. and W.E. James, 1991, Growth patterns of the Japanese economy in the 1980s: Before and after the appreciation of the Yen. *Economic Systems Research* 3, 4, pp. 399-412.
- Holland, D. and S.C. Cooke, 1992, Sources of structural change in the Washington economy: An input-output perspective. *The Annals of Regional Science* 26, 2, pp. 155-170.
- Isard, W., 1951, Interregional and regional input-output analysis a model of a space economy. *The Review of Economics and Statistics*, 33, pp. 318-328.
- Kanemitsu, H. and H. Ohnishi, 1989, An input-output analysis of technological change in the Japanese economy: 1970-1980. In: R.E. Miller, K.R. Polenske and A.Z. Rose (eds.), *Frontiers of Input-Output Analysis*. Oxford University Press, New York/Oxford, pp. 308-23.
- Kubo, Y., S. Robinson and M. Syrguin, 1986, Chapter 5. In: H. Chenery, S. Robinson and M. Syrguin (eds.), *Industrialization and Growth, a Comparative Study*. Oxford University Press, Oxford.
- Langer, C., 1987, *Produktionsverflechtung in der EG, Ein interregionales Input-Output Modell für die Staaten der Europäischen Gemeinschaft*. Veröffentlichungen des HWWA-Institut für Wirtschaftsforschung, Weltarchiv, Hamburg.
- Lanza, A. and G. Rampa, 1988, A Model for Assessing the Growth Opportunities of EEC Countries when Interdependence is not Ruled out. In: M. Chiaschini (ed.), *Input-Output Analysis, Current Developments*. Chapman and Hall, London.
- Linden, J.A, and J. Oosterhaven, 1995, EC Intercountry Input-Output Relations: construction Method and Main result for 1965-1985. *Economic Systems Research* 7, 3, pp. 249-270 .
- Lee, C., 1990, Growth and changes in the structure of the US agricultural economy, 1972-82: An input-output perspective. *Economic Systems Research* 2, 3, pp. 303-11.
- Leontief, W., 1941, *The structure of the American Economy*. Oxford University Press, New York.

- Maddison, A., 1991, *Dynamic forces in capitalist development*. Oxford University Press, Oxford.
- Miller, R.E. and P.D. Blair, 1985, *Input-Output Analysis: Foundations and Extensions*. Prentice Hall, Englewood Cliffs.
- Oosterhaven, J., 1981, *Interregional Input-Output Analysis and Dutch Regional Policy Problems*. Gower, Aldershot, Hampshire.
- Oosterhaven, J., 1995, *Changing Specialization and Interdependency of EC-countries 1959-1975*. *Australasian Journal of Regional Studies* 1, 1 (too appear).
- Schilderlinck, J.H.F., 1984, *Interregional Structure of the European Community, Part II. Interregional Input-Output Tables of the European Community, 1959, 1965, 1970 and 1975*. Tilburg University.
- Skolka, J., 1989, Input-output structural decomposition analysis for Austria. *Journal of Policy Modelling* 11, pp. 45-66.
- Stäglin, R. and H. Wessels, 1972, Intertemporal analysis of structural change in the German economy. In: A. Bridy and A.P. Carter (eds.), *Input-Output Techniques*. Amsterdam, North-Holland, pp. 370-92.
- UN, 1975, *A system of quantity and price statistics*. United Nations, New York.
- Uno, K., 1989, *Measurement of services in an input-output framework*. Amsterdam, North-Holland.